PHYS 2380 Quantum Physics I
Term Test March 6, 2008, 19:00 hrs to 21:00 hrs
519 Allen Bldg.

1. The earth is thermal equilibrium. It receives 338 W/m^2 of energy from the sun and radiates an equivalent amount back into the universe. Assuming that the earth radiates like a black body, estimate the mean temperature of the earth. (6 points)

2. Bohr model for the hydrogen atom gives the allowed energies for the electron as

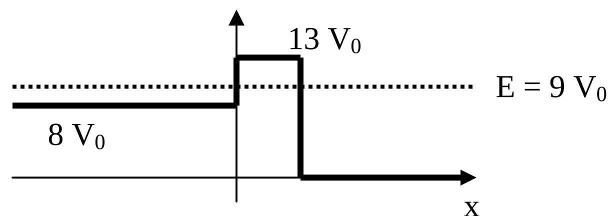
$$E_n = -\frac{13.6}{n^2}\ eV\ .$$

a) What is the shortest wavelength of the spectral series terminating on level n = 3? (3 points)

b) What would be the energy of an electron whose de Broglie wavelength would be the same as the photon from part (a) (3 points)

3. A particle of energy $E = 9\ V_0$ is incident from the left on the potential shown below (not to scale):

V(x)	$= 8V_0$	for	$x < 0$
	$= 13\ V_0$	for	$0 < x < a$
	$= 0$	for	$x > a$



Where $V_0 = \frac{\hbar^2\pi^2}{2ma^2}$

a) Write down the most general forms for the wave functions that satisfy the Schrödinger equation in each of these 3 regions. Explain your choices. (3 points)

b) With the information that the particle is incident from the left can any of the coefficients for the components of the wave functions be set to zero? Explain. (3 points)

c) Use the appropriate boundary conditions at x = 0 and x = a to obtain all of the remaining coefficients in terms of one of them. (9 points)

d) What is the transmission probability for particle across this potential? A numerical final answer should be possible. (6 points)

Some Constants:

Speed of light = c = 2.998 x 10^8 m/s
Electron Charge = e =1.602 x 10^{-19} C
Planck's constant = h = 6.626 x 10^{-34} J-s
Boltzmann's constant = k = 1.381 x 10^{-23} J/K
Stefan-Boltzmann constant = σ = 5.67 x 10-8 W/m^2-K^4
Electron Mass = m_e = 9.11 x 10^{-31} kg = 0.511 MeV/c^2

Some equations:

$R_T = \sigma T^4$

λ_{max} T = 2.898 x 10^{-3} m-K

$$\rho_T(\nu) = \frac{8\pi\nu^2}{c^3}\frac{h\nu}{e^{h\nu/kT}-1}d\nu$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2}+V(x)\Psi(x,t)=i\hbar\frac{\partial\Psi(x,t)}{\partial t}$$